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STRATEGIC WEAPONS ASSESSMENT NOMOGRAPH

AN INVESTIGATIVE TOOL FOR DECISION MAKERS & ANALYSTS

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STRATEGIC WEAPONS ASSESSMENT NOMOGRAPH

In comparing the capabilities of strategic nuclear weapons, detailed models are often chosen to analyze one specific characteristic of each weapon to determine its relative merits. However, it is difficult to assess the overall capabilities of weapons without looking at these numerous characteristics simultaneously. Furthermore, reliance on detailed models hinders analysts and decisionmakers in performing quick tradeoffs among various characteristics in order to better determine the direction, if any, of indepth analyses. Finally, a better understanding of the interrelationships among these characteristics could provide helpful insights in guiding studies and decisions. The Strategic Weapons Assessment Nomograph (SWAN) addresses these concerns. Though one can obtain "ballpark" values for probability of damage (PD) and damage expectancy (DE), the SWAN is best suited for showing the relationships among various weapons systems parameters and the tradeoffs of adjusting one or more of these aspects for a particular weapon.

Model Description

The SWAN uses six key parameters: circular error probable (CEP), yield, target hardness, pre-launch survivability (PLS), weapon system reliability (WSR), and probability to penetrate (PTP). Each parameter appears separately on the nomograph yet all are interrelated through a fixed mapping structure as shown in Figure 1. To best understand this, consider the example plotted on the SWAN:

CEP	300 feet
Yield	100 KT
Hardness	6000 psi
PLS	0.9
WSR	0.9
PTP	0.9

Tracing through the model, enter on the CEP scale at 300 feet, then move down to the 100 KT line. At this point of intersection, move left to the hardness chart to the 6000 psi line. Now, move down to the PLS chart intersecting the 0.9 line. (Note that the PD scale was crossed at about 0.68, the probability of damage based on a 300 feet CEP, a 100 KT yield, and a 6000 psi target.) From the PLS chart, move right to the WSR chart, stopping at the 0.9 line. Next, move down to the 0.9 PTP line. Finally, move right to the DE scale, reading a 0.50 DE.

The path followed in this example is just one possible way to use the SWAN. You could enter at any point and trace in any direction clockwise or counterclockwise, so long as you proceed along the designated path. However, note that the WSR/PTP chart is actually a dual chart with a common line at 1.0. The portion of the graph above the 1.0 line represents WSR and the portion below 1.0 is PTP. When moving to this chart from PLS, you must first enter the WSR portion and then drop down to the PTP portion before reading DE. Moving from PLS to PTP before moving to WSR will give an erroneous DE. Thus it's important to maintain the relationships between 'adjacent' parameters, as described.

Model Restrictions

There were two key assumptions made in building the SWAN. Removing these assumptions would require multiple versions of the model and increase its complexity at the expense of usability.

The first assumption concerns offset distance, commonly used in targeting multiple soft targets with a single weapon. The model assumes a zero offset distance, thereby narrowing the model's applicability to single-weapon-on-single-target analysis. The SWAN could be modified to account for offset distances but would result in a different version of the SWAN for each specific combination of offset distance and target hardness desired.

The second assumption concerns the VNTK system, which specifies target hardnesses. Under this system, the SWAN assumes the target is very sensitive to overpressure duration; the damage level is based on the amount of overpressure applied to the target and how long it is applied. Based on target construction characteristics, the SWAN is probably most appropriate in analyzing weapon systems vis-a-vis harder targets since the model assumes relatively high pressure duration sensitivity. However, for softer targets viewed under the single-weapon-on-single-target constraint, the level of pressure duration sensitivity has relatively little effect on the probability of damage. Therefore gearing the model towards high sensitivity to make the SWAN more accurate for harder targets does not invalidate its use against softer targets.

Model Insights

As previously mentioned, the SWAN is well suited for single-weapon-on-single-target analysis. Thus it may be used to assess the impact of variations in weapon system parameters. To explain, I offer the following examples:

1. Maintaining all characteristics of a weapon and target except CEP, one could see how quickly PD and likewise DE improve as CEP is lowered. Then, fixing CEP but altering yield, one could see how much additional yield is needed to achieve the same levels of PD and DE as before. Realizing that CEP improvements typically cost more than yield increases, tradeoffs between yield and CEP could be assessed in planning for a modernization program. One will note that, once a PD value of 0.9 is reached for a given target, additional improvements in CEP and/or yield are of marginal value against that target.

2. Maintaining all weapon and target characteristics except PTP, one could see how improved defenses (i.e., lower PTP) affect DE. This could be done for blue-on-red force analysis as well as red-on-blue.

3. Maintaining all weapon characteristics, one could see how increased hardness affects PD and DE. In this case,it will become apparent that hardness changes of as much as 20% will have a relatively small effect on PD and DE (i.e., less than 5%). Thus, an assessment of hardening programs could be done to see how much change in hardness is needed before a significant change in DE occurs. This type of analysis could be applied to blue-on-red forces as well as red-on-blue.

4. One could assess the value of a particular weapon system by plotting all of its characteristics against some desired hardness level. Repeating this for several weapon systems against the same hardness level could help to determine the relative merit of each system. This could be beneficial in assessing tradeoffs in arms control as to which weapons are more 'valuable' and to what degree.

5. Combinations of examples 1 - 3 could be done to try to find some optimal type of force modernization program. That is, relatively easy and/or inexpensive improvements in numerous weapon systems characteristics could offer equal or greater benefits than a concentrated effort of improving only one or two specific characteristics.

These examples are only a taste of the types of applications for which the SWAN is suited. Though one must be cautioned not to push the SWAN beyond its limitations, this graphic portrayal of the interrelationships among the DE parameters has some definite utility, as demonstrated by the previous examples.

Concluding Remarks

Again, the SWAN's greatest merit lies in examining overall relationships among weapon system characteristics. It is not a stand alone analytical tool. Instead, as insights are revealed through its use, it should serve as a stepping stone to more detailed analysis. But its value in determining the direction of that analysis could be immeasurable. For a more detailed discussion of the SWAN and its uses, reference the Tutorial on the Strategic Weapons Assessment Nomograph by AF/SASF.

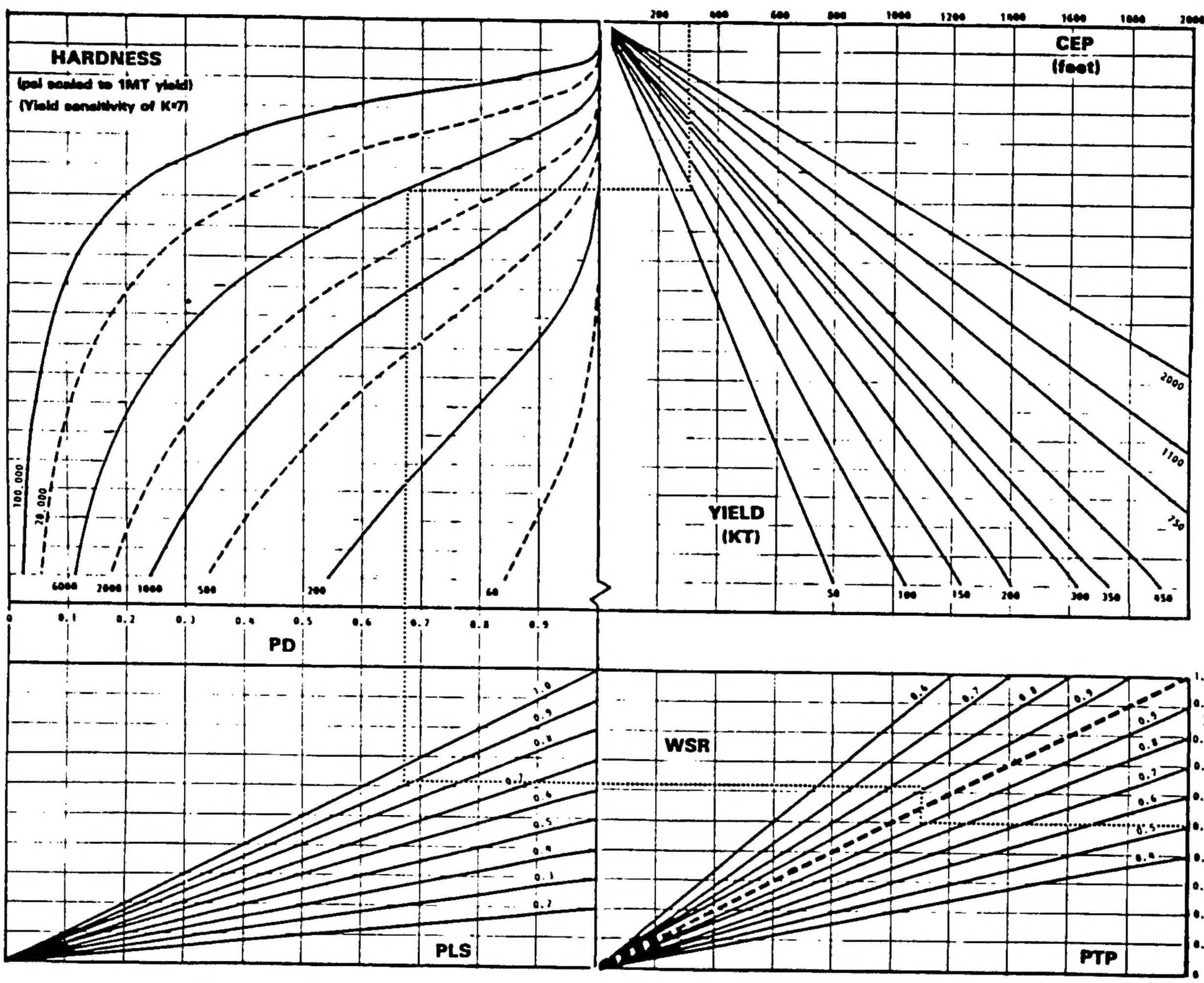

Figure 1. Strategic Weapons Assessment Nomograph

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